MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

EEM1026 – ENGINEERING MATHEMATICS II

(All Sections / All Groups)

27 OCTOBER 2017

3.00 p .m. – 5.00 p.m.

(2 Hours)

INSTRUCTIONS TO STUDENT:

1. This exam paper consists of 6 **pages** (including cover page) with 4 Questions only.

2. Attempt all the questions. All questions carry equal marks and the distribution of marks for each question is given.

2. Please write all your answers in the Answer Booklet provided. Show all relevant steps to obtain maximum marks.

3. Only NON-PROGRAMMABLE calculator is allowed.

Question 1

(a) Solve the first order linear equation.

$$(x+1)\frac{dy}{dx}+2y=6x+6$$

[5 marks]

(b) By using the method of undetermined coefficients, find the complementary function (y_c) and the particular solutions (y_p) of the following inhomogeneous differential equations. Determine the values of each coefficient for the particular solutions (y_p).

$$2\frac{d^2y}{dx^2}+18y=24x\sin 3x$$

[9 marks]

(c) Consider the solution of $y''-2xy=0$ in the form of power series in x about $x_0=0$, i.e., $y=\sum_{n=0}^{\infty}c_n x^n$. Find the first five nonzero terms of this series solution.

[11 marks]

Question 2

(a) Use Laplace transform to solve the following differential equation:

$$2y''+10y'+12y=4e^{-t} \quad (t\geq 0)$$

Given the initial condition: $y(0)=1, y'(0)=0$ at $t=0$. [9 marks]

(b) If y(t) and u(t) are signals with Fourier transforms Y(ω) and U(ω) respectively, and

$$\frac{d^2y(t)}{dt^2}+12\frac{dy(t)}{dt}+9y(t)=6\frac{du(t)}{dt}+6u(t)$$

show that Y(ω) = G(ω)U(ω) for some function G(ω). What is G(ω)?

[8 marks]

(c) Find the z transform, $Y(z)$ of the following differential equation

$$y_{k+2}-\frac{6}{8}y_{k+1}+\frac{1}{8}y_k=\frac{9}{8} \qquad (k\geq 0)$$

given that $y_0=1$ and $y_1=3/2$. [8 marks]

Continued...

Question 3

(a) By using D'Alembert formula: $u(x,t)=\frac{1}{2}[f(x-ct)+f(x+ct)]+\frac{1}{2c}\int_{x-ct}^{x+ct} g(\xi)\,d\zeta$,

solve:

$u_{tt}=16u_{xx} \quad -\infty \le x \le \infty; \quad t>0$

$u(x,0)=6x \quad ; \quad u_t(x,0)=4x^2 \quad ; -\infty \le x \le \infty$

Simplify your answer. [10 marks]

(b) Solve using method of separation of variables:

$\frac{\partial u}{\partial x}=6\frac{\partial u}{\partial y}$; where $u(0,y)=6e^{-6y}$. [15 marks]

Question 4

(a) An electronics company manufactures resistors that have a mean resistance of $100\,\Omega$ and a standard deviation of $10\,\Omega$. The distribution of resistance is normal. Find the probability that a random sample of $n=25$ resistors will have an average resistance less than $95\,\Omega$.

[8 marks]

(b) The high temperature in Ayer Keroh for the month of July is distributed normally with standard deviation of $\sigma=3°C$. A random sample of 10 day's temperature in Ayer Keroh during July 2017 resulted with a mean of high temperature as $29.5°C$.

i) What is the point estimate for the population mean of high temperature in Ayer Keroh for the month of July?

[1 mark]

ii) Construct a 95% confidence interval for the high temperature in Ayer Keroh for the month of July.

[4 marks]

(c) The height of students in Faculty of Engineering and Technology is normally distributed, and a lecturer claims that the mean height of these students is 1.68 metres. To test this claim, another lecturer takes a random sample of 16 students and finds that the mean is 1.71 metres and the standard deviation is 0.05 metres. Can the claim made by the lecturer be accepted at the 0.05 level of significance?

[12 marks]

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APPENDIX

Table I: Laplace transform for some of function $f(t)$

$f(t)$	$F(s) = \mathcal{L}\{f(t)\}$
1	$1/s$
t	$1/s^2$
$t^n (n = 1, 2, 3, \ldots)$	$n!/s^{n+1}$
e^{at}	$\frac{1}{s-a}$
te^{at}	$\frac{1}{(s-a)^2}$
$t^{n-1}e^{at}$	$\frac{(n-1)!}{(s-a)^n}, n = 1,2,\ldots\ldots$
$\cos at$	$\frac{s}{s^2+a^2}$
$\sin at$	$\frac{a}{s^2+a^2}$
$\cosh at$	$\frac{s}{s^2-a^2}$
$\sinh at$	$\frac{a}{s^2-a^2}$
$u(t-a)$	$\frac{e^{-as}}{s}, a \geq 0$
$f(t-a)\,u(t-a)$	$e^{-as}\mathcal{L}(f)$
$f(t)\,\delta(t-a)$	$e^{-as}f(a)$
$f'(t)$	$s\mathcal{L}(f) - f(0)$
$f''(t)$	$s^2\mathcal{L}(f) - sf(0) - f'(0)$

Continued....

Table II: Table of Fourier Transform

$f(x)$	$F(w) = F\{f(x)\} = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{-iwx} dx$
$\frac{1}{x^2 + a^2} \quad (a > 0)$	$\sqrt{\frac{\pi}{2}} \frac{e^{-a\lvert w\rvert}}{a}$
$H(x)\, e^{-ax} \quad (\mathrm{Re}\ a > 0)$	$\frac{1}{\sqrt{2\pi}} \frac{1}{(a + iw)}$
$H(-x)\, e^{-ax} \quad (\mathrm{Re}\ a > 0)$	$\frac{1}{\sqrt{2\pi}} \frac{1}{(a - iw)}$
$e^{-a\lvert x\rvert} \quad (a > 0)$	$\frac{1}{\sqrt{2\pi}} \frac{2a}{(w^2 + a^2)}$
e^{-x^2}	$\frac{1}{\sqrt{2}} e^{-\frac{w^2}{4}}$
$\frac{1}{\sqrt{\lvert x\rvert}}$	$\frac{1}{\sqrt{\lvert w\rvert}}$
$H(x + a) - H(x - a)$	$\frac{1}{\sqrt{2\pi}} \frac{2 \sin aw}{w}$
$\delta(x - a)$	$\frac{1}{\sqrt{2\pi}} e^{-iaw}$
$F\left(\frac{df}{dt}\right)$	$(i\varpi) F(\varpi)$
$F\left(\frac{d^2 f}{dt^2}\right)$	$(i\varpi)^2 F(\varpi)$

Continued....

Table III: Table of z- Transform.

$\{x_k\}$	$F(z)$
e^{-ak}	$\frac{z}{z-e^{-a}}, \lvert z\rvert > e^{-a}$
a^k	$\frac{z}{z-a}, \lvert z\rvert > \lvert a\rvert$
ka^k	$\frac{az}{(z-a)^2}$
k^2a^k	$\frac{az(z+a)}{(z-a)^3}$
$Z\{x_{k+1}\}$	$z\,Z\{x_k\} - zx_0$
$Z\{x_{k+2}\}$	$z^2\,Z\{x_k\} - z^2x_0 - zx_1$

Table IV: Table of Undetermined Coefficients

Term in $r(x)$	Choice for y_p
ke^{px}	Ce^{px}
$kx^n\ (n = 0,1,\ldots)$	$K_0x^n + K_1x^{n-1} + \cdots + K_{n-1}x + K_n$
$k\cos wx$ $k\sin wx$	$Kcoswx + Msinwx$
$ke^{px}\cos wx$ $ke^{px}\sin wx$	$e^{px}(Kcoswx + Msinwx)$
kx^ne^{px}	$(K_0x^n + K_1x^{n-1} + \ldots + K_{n-1}x + K_n)\,e^{px}$
$kx^n\sin wx$ $kx^n\cos wx$	$(K_0x^n + K_1x^{n-1} + \ldots + K_{n-1}x + K_n)\sin wx$ $+(M_0x^n + M_1x^{n-1} + \ldots + M_{n-1}x + M_n)\cos wx$

End of paper.